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# NEW ECHINOIDS FROM THE RIPLEY GROUP OF MISSISSIPPI

By

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Assistant Curator, Section of Invertebrate Paleontology.

---

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CHICAGO, U. S. A.

May 15, 1909.





# NEW ECHINOIDS FROM THE RIPLEY GROUP OF MISSISSIPPI.

BY ARTHUR WARE SLOCOM

The specimens upon which this paper is based were collected by the writer in the spring of 1908, during a trip made to Mississippi for the purpose of obtaining a representative series of fossils from the well-known Cretaceous and Tertiary deposits of that state.

The Ripley formation of Mississippi, from which the specimens here described were obtained, extends southward from Tennessee, on the border of which state it has a width of about 10 miles. In the southern part of Tippah County it widens out to about 15 miles and from thence gradually narrows as it passes south through Union and Pontotoc Counties until near Houston in Chickasaw County it disappears altogether. For the most part this formation occupies the highlands and is locally known as the Pontotoc Ridge. Over a large part of this region the Ripley is overlain by red sands and clay of the Lafayette and Wilcox groups, so that the Ripley beds are often found in the gullies and along the streams and are recognized on account of their light color. They are locally called "white gullies."

At Pontotoc, Mississippi, three localities were visited, viz: (1) the Patterson farm about three miles southeast of town; (2) the bluffs on either side of One Mile Run, about a mile south of town on the Houston road; and (3) the roadside near the southern edge of the village. These two latter outcrops are similar in position, comparatively near together and will be considered in this paper as one locality. The outcrop on the Patterson farm lies somewhat higher than the other two and is probably higher geologically. At all these localities well preserved echinoids were found. About 200 specimens were collected which proved, on examination, to represent six species, four of which are new and are here described.

## CLASSIFICATION AND TERMINOLOGY.

The classification here used is that prepared by P. M. Duncan,\* and given in the English edition of Zittel's Text Book of Paleontology.

\* P. M. Duncan 1889, Revision of the Genera and Great Groups of the Echinoidea, Jour. Linnean Soc. Vol. XXIII.

FIELD MUS. NAT. HIST. GEOL. SER. VOL. IV, No. I.

The terminology of Desor\* with some modifications is adhered to. It may be briefly stated as follows:

*Echinoids or Sea Urchins:* Marine animals without arms or stem, the bodies encased in a solid or slightly flexible test or shell, varying in shape from spherical to flat; composed of numerous closely placed plates, covered with spines. The mouth is on the ventral or actinal surface; the anus either in the apical system or somewhere in the posterior interambulacral area. The plates of the ambulacral areas are more or less extensively perforated for the protrusion of the ambulacra or tube feet.

*Dorsal Surface:* (A†) The upper, usually convex surface, on which are situated the apical system, petals, etc.

*Ventral or Actinal Surface:* (C) The lower surface on which the peristome is situated.

*Anterior Sulcus:* (as) A more or less distinct groove in the anterior margin of the test. In it is situated the anterior ambulacral area.

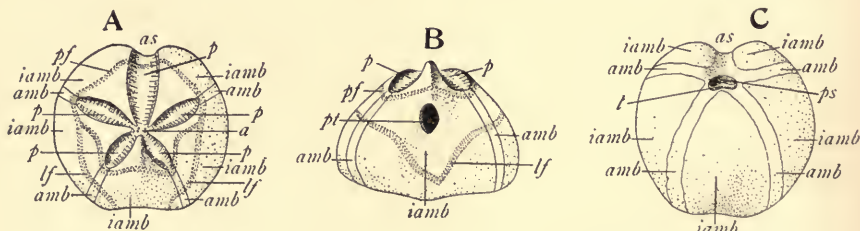


Fig. 1. Diagram of *Linthia variabilis*. A, dorsal view. B, posterior view. C, ventral view.

*Ambulacral (amb.) and Interambulacral Areas: (iamb.)* The test of practically all echinoids is divided into ten segments or areas, five ambulacral and five interambulacral areas. In living echinoids and most Mesozoic or Cenozoic fossil echinoids, including all species mentioned in this paper, each area consists of two rows of plates.

*Poriferous Zones:* On each side of the ambulacral areas are bands or zones containing openings or pores through which issue the tentacles or tube feet. There are ten poriferous zones, two to each ambulacral area. In some echinoids there is quite a space between the poriferous zones and this space is called the *interporiferous zone*.

*Simple Ambulacra:* Those in which the pores of the poriferous zones have the same disposition from the apex to the peristome. This is the case in all "regular echinoids."

\* E. Desor 1858. Synopsis des Echinides Fossiles Paris.

† The letters in parentheses refer to those of Figs. 1 and 2.

*Petaloid Ambulacra*: In some genera the ambulacral areas are wide near the apex and the poriferous zones are bounded by a groove. The part of the area having this form is called the petal (p). In other genera the poriferous zones are similar in form to the above, but the petals are not closed at their distal ends and the zones continue. The disposition of the pores is, however, radically changed. Areas having this form are called *subpetaloid*.

*Apical System* (a): A disc ordinarily composed of ten plates, (Pl. II fig. 5) five of which called *genital plates* form the summits of the interambulacral areas and five called *radial plates*, by some authors *oculars*, form the summits of the ambulacral areas. Two or more of the genital plates may be fused, thus reducing the number. One of the genital plates is usually larger than the others and bears a spongy protuberance filled with minute pores called the *madreporite*.

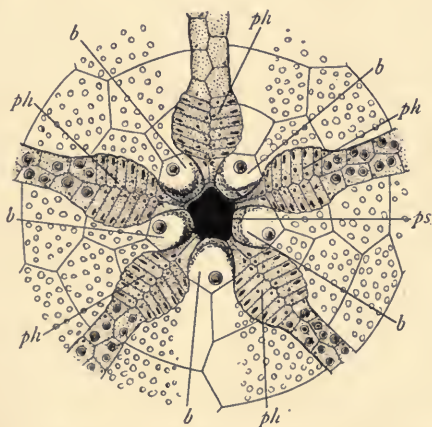


Fig. 2. Diagram of the floscelle of *Cassidulus intermedius*.

*Floscelle*: (Fig. 2) In the family Cassidulidæ the ambulacral areas assume a peculiar flowerlike form around the peristome, called the floscelle. The floscelle is composed of five enlargements of the poriferous zones called the *phyllodes* (ph). These five phyllodes are separated from each other by five inflated plates of the interambulacral areas about the peristomal margin. These inflated plates are called *bourrelets* (b).

*Fascioles*: Narrow bands apparently smooth but in reality formed of microscopic tubercles, which during life bear vibrating cilia. They have been divided into: (1) the *peripetalous fasciole* (pf) which surrounds the petals; (2) the *marginal fasciole* which follows the sides; (3) the *subanal fasciole* which is limited to the posterior face; and (4)

the *lateral fasciole* (lf) which branches from the peripetalous fasciole and passes beneath the periproct.

*Tubercles*: (Pl. II figs. 8,9.) Wart-like protuberances which occur on the plates of most echinoids. They vary in size from quite large to microscopic granulations. Tubercles consist of two parts, the *boss* and the *mamelon*. The base or boss may be either plain or crenulated. The mamelon is a small rounded protuberance above the boss to which in life, a spine is attached. A plain or sunken space surrounding the boss generally marked by a ring of granules is called the *areole* or *scrobicule*.

*Periproct* (pt): The upper or posterior opening in the shell, improperly called the anus, but which contains the latter. The periproct is closed by a membrane to which the anal plates are attached. These plates may be few and symmetrical, or numerous and irregular, and arranged concentrically about the anal opening. The position of the periproct is within the apical system in "regular echinoids" but in "irregular echinoids" it is situated somewhere in the posterior interambulacral area. It may be either on the dorsal or ventral surface. The position of the periproct is of great systematic importance.

*Peristome* (ps): The lower opening of the shell; it is situated on the ventral surface, either at the center or on the median line between the center and the anterior margin. In form it may be decagonal, pentagonal, oval, bilabiate, etc. It contains the buccal membrane in the center of which the mouth is situated.

*Labrum*: (l) The posterior lip of the peristome.

*Proximal*: Nearest to the apex.

*Distal*: Farthest from the apex.

*Lateral*: Pertaining to the side.



## DESCRIPTION OF GENERA AND SPECIES.

## Order SPATANGOIDA.

## Family CASSIDULIDÆ.

## Genus CASSIDULUS Lamarck 1801.

Test small, oblong, depressed, broadest posteriorly, longer than broad, broader than high, convex dorsally, flat or concave ventrally.

Apical system eccentric in front or subcentral; four perforated genital plates; the madreporite passing back and separating the postero-lateral genitals but not the radial plates. Ambulacral areas subsimilar, short, flush, subpetaloid, not closing; pores continued from the petaloid part to the floscelle, which is well developed. Tentacles both simple and branchial (heteropodous). Peristome eccentric in front, the bourrelets narrow and strong, the phyllodes in grooves, One peristomal plate to each interradium. Usually a median band behind the peristome where there are no tubercles and where the test is either cribriform, pitted or plain, or it may be absent. Periproct supramarginal, in a depression or at the commencement of a groove, elongated longitudinally. Tubercles small and very close together on the dorsal surface, large and separated on the ventral, except on the longitudinal median area.

Range Cretaceous and Eocene.

## CASSIDULUS SUBQUADRATUS Conrad.

1860. *C. subquadratus* Conrad, Jour. Acad. Nat. Sci. Phil., 2nd ser.

Vol. 4, p. 291, pl. 47, fig. 19.

1891 *C. subquadratus* Clark, Johns Hopkins Univ. Circ. No. 87, p. 76.

1893 *C. subquadratus* Clark, Bull. U. S. G. S. No. 97, p. 70, pl. 31, fig. 1 a-h.

Original description: "Suborbicular, flat beneath, flexuous posteriorly; lateral and end slopes truncated; anus very large, obtusely ovate, with a depression beneath, extending to the margin, which at that point is salient; ambulacra lanceolate.

Length  $3\frac{1}{8}$  inches; Diameter  $2\frac{3}{4}$  inches; Height  $1\frac{3}{4}$  inches.

Locality. Tippah county, Mississippi." Clark gives Holly Springs as the locality of this species.

No entire specimens of this species were collected by the writer, but six fragments, Cat. No. P 10345, of sufficient size for identification were found on the Patterson farm near Pontotoc, Mississippi.

*CASSIDULUS INTERMEDIUS* sp. nov. Plate I, Figs. 1-6.

Test oval, greatest width posterior to the center; rounded anteriorly, slightly rostrated posteriorly; dorsal surface convex, apex eccentric anteriorly and inflated, sides declining about equally towards the margins which are slightly inflated; the peristomal concavity occupying more than half of the ventral surface. Ambulacral areas narrow and flush, poriferous zones subpetaloid on the upper part of the dorsal surface to a point varying in the different areas from about one third to nearly one half the distance from the margin to the apical system; the zones are then contracted and continue as narrow bands over the margin to the vicinity of the peristome, where they abruptly widen, and again narrow to the peristome forming a floscelle. The pores are distant and paired on the petaloid portion and in the floscelle; on the narrow connecting portions they are single, small and indistinct. In the petaloid areas the pores of the outer rows are slit-like, those of the inner rows round and smaller; each pair is connected by a groove. Interambulacral areas composed of large plates, the plates nearest the peristome in each area inflated forming the bourrelets. Dorsal surface covered with small crowded tubercles with slightly sunken areoles, the tubercles on the ventral surface rapidly increasing in size and distance apart as they approach the peristome. A wide, longitudinal median band extends from near the anterior margin through the floscelle to the posterior margin. This band is without tubercles and the surface is smooth except where it passes through the floscelle. The apical system in the type specimen is too incomplete for detailed description, but appears similar to other species of this genus. The peristome is situated slightly in front of the center of the ventral surface, pentagonal, surrounded by a well-marked floscelle, the bourrelets large and prominent, the phyllodes very narrow as they reach the peristome and situated in grooves. The periproct is elongated longitudinally and situated on the dorsal surface at about one third the distance from the posterior margin to the apex in a deep groove. The dimensions of the type specimen are: Length 25.6 mm., width 22.7 mm., height 9.6 mm.

This description is based on a single specimen, Cat. No. P 10346, collected by the writer. The specimen had been slightly crushed on the left side, a few of the plates of the left interambulacral area and part of the apical system are missing, but the general form and all

other parts of the test are complete. In general form this species resembles *C. æquoreus*, but it is not so high in proportion to its length, the periproct is somewhat higher, the pores in the outer rows of the petaloid portions are slitlike instead of round and the expansions of the phyllodes are wider. *C. intermedius* resembles *C. micrococcus* in the slitlike pores of the outer rows of the petaloid areas and in the expansion of the phyllodes, but the position of the pores in these expansions is more like those of *C. æquoreus*. The position of the periproct is midway between that of *C. micrococcus* and *C. æquoreus*, the size and shape of the test is quite unlike *C. micrococcus* and the extension of the longitudinal median band in front of the peristome on the ventral surface does not appear, from the description and figures, to occur in either of the other species. The name adopted for this species refers to the characters intermediate between *C. æquoreus* and *C. micrococcus* which the species exhibits.

Locality: Ripley Group near the southern edge of the village of Pontotoc, Mississippi.

CASSIDULUS HEMISPHERICUS sp. nov. Plate I, Figs. 7-9.

Test subhemispherical with its transverse diameter somewhat shorter than the longitudinal, sides arcuate, margins angular, ventral surface flat or nearly so. Ambulacral areas wide, subpetaloid on the top of the dorsal surface, not closed distally, petals subequal in length, extending about half way from the apex to the margin, slightly convex; from the distal end of the petals the ambulacral areas are continued as a band which gradually increases in width from the petal to the margin, most of the way being wider than the petal. On the ventral surface the bands slightly narrow to the floscelle. The floscelle is not well preserved in the type specimen, but enough is preserved to determine that the bourrelets are prominent and that the phyllodes are in grooves. The apical system is central but the form of the various plates of which it is composed cannot be determined. The interambulacral areas are about equal in size. They form an acute angle near the apex and rapidly expand to the margin, the plates being comparatively large. All the plates of the dorsal surface, with the exception of those of the petals, are marked by prominent lines subparallel to the edge of the plates. These lines are farther apart on the lateral edges than on the proximal and distal edges. They appear to be lines of growth. The middle portion of the plates within this series of lines is inflated, so that in the small plates of the interambulacral areas, near the apex, the centers of

the plates appear as prominent nodes. These middle portions of the plates are free from tubercles, but the parts of the plates covered by the parallel lines and the plates of the petals are covered with minute tubercles closely crowded together. The lines are much less prominent on the plates of the ventral surface and the tubercles are larger, with slightly sunken areoles and more evenly distributed over the surface except on the longitudinal median band, which extends from the peristome to the posterior margin. The peristome is situated at the center of the ventral surface, surrounded by a floscelle, the bourrelets are prominent and the phyllodes are depressed and contracted into narrow grooves, where they reach the peristome. The periproct is supramarginal, but its form and exact position are unknown because that portion of the posterior interambulacral area near the margin is missing. The measurements of the type specimen, Cat. No. P 10347, are: Length 34.7 mm. width 26.7 mm., height 19.5 mm. Allowing for the lateral crushing it is probable that the length and width were originally about 32 mm. and 29 mm. respectively.

It is to be regretted that other and more perfect specimens of this species could not have been found and the writer has endeavored to obtain such specimens by correspondence, but so far without success. The specimen on which the description is based is crushed laterally, and in three of the interambulacral areas and the region about the peristome there are some plates missing. Three of the ambulacral and two of the interambulacral areas are practically complete. The entire petaloid portion of the dorsal surface is in good condition, so that the only important character that is in doubt is the exact form and position of the periproct. The five pairs of plates above the margin in the posterior interambulacral area are missing and the periproct was situated somewhere within this space. The specific name is adopted on account of the hemispherical form of the test, which distinguishes it to a marked degree from any other species of the genus.

Locality: The type specimen was collected by the writer in the "white gullies" of the Ripley Group on the Patterson farm, about three miles south of Pontotoc, Mississippi.



## Family SPATANGIDÆ.

## Genus HEMIASTER Desor 1847.

Urchins with a short, elevated, oval or cordiform test. Apical system in general excentral and posterior. Ambulacral areas petaloid, unequal in length, and lodged in depressions of the dorsal surface; poriferous zones large and equal in the same ambulacral area, pores elongated and placed close together. Anterior area lodged in a long shallow sulcus; poriferous zones very narrow and composed of small round pores sparsely disposed in oblique, widely separate, simple pairs. Fasciole single, peripetalous, and circumscribing the ambulacral areas. Apical disc small and compact, four perforated genital plates, and five very small radial plates. Peristome bilabiate, very excentral, opening at the anterior fourth part of the base. Periproct opening high up on the posterior border, which is in general flat, and obliquely truncated.

*Hemiaster* differs from *Micraster* in having a single peripetalous fasciole and no anal fasciole; the test is likewise in general shorter, more inflated, and the posterior pair of ambulacral areas are much shorter than the anterior pair. *Hemiaster* differs from *Linthia* in having only a peripetalous fasciole, the latter having both peripetalous and lateral fascioles.

Range Cretaceous to Recent.

## HEMIASTER PARASTATUS (Morton).

1830. *Spatangus* sp. Mort., Am. Jour. Sci., 1st ser., Vol. 17, p. 286.

1830. *S. cor-marinum* (?) Mort., Am. Jour. Sci., 1st ser., Vol. 18, p. 250, pl. 3, fig. 10.

1830. *S. cor-marinum* (?) Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., Vol. 6, p. 199.

1833. *S. parastatus* Mort., Am. Jour. Sci., 1st ser., Vol. 23, p. 294.

1834. *S. parastatus* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 77, pl. 3, fig. 21.

1853. *Hemiaster parastatus* Marcou, Explan. Text to Geol. Map. U. S., and Brit. Prov. N. A., p. 47, pl. 7, fig. 8.

1855. *H. parastatus* d'Orb., Pal. France, Terr. Cret., Vol. 6, p. 265, pl. 894, fig. 4.

1864. *H.* (?) *parastatus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.

1891. *H. parastatus* Clark, Johns Hopkins Univ. Circ., Vol. 10, No. 87, p. 77.

1893. *H. parastatus* Clark, Johns Hopkins Univ. Circ., Vol. 12, No. 103, p. 52.

1893. *H. parastatus* Clark, Bull. U. S. G. S., No. 97, p. 83, pl. 45, figs. 1 a-m.

1905. *H. parastatus* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 7.

1907. *H. parastatus* Weller, Paleontology of New Jersey, Vol. 4, p. 298, pl. 15, figs. 1-13.

This species was described from the Upper Cretaceous limestone of Timber Creek, New Jersey, and has been reported from the Ripley Group of Alabama.

Five specimens of this species, Cat. No. P 10341, were collected by the writer near the southern edge of the village of Pontotoc, Mississippi, in the so-called "white gullies" of the Ripley Group.

HEMIASTER LACUNOSUS sp. nov. Plate II, Figs. 1-7.

Test small, indistinctly cordate, ventral surface moderately convex, dorsal surface convex, strongly elevated in the posterior interambulacral area and gradually sloping with an indistinct anterior sulcus; anterior and lateral borders inflated, posterior margin truncated. Ambulacral areas petaloid, with straight petals situated in depressions of the surface, the antero-lateral pair nearly twice as long as the postero-lateral pair; poriferous zones of the paired petals wide, pores transversely elongate and situated far apart. Anterior petal longer but narrower than the others and situated in a deep depression which grades into an indistinct anterior sulcus; poriferous zones of this petal narrow and far apart; pores small, round and separated by a tubercle. Interambulacral areas broad and composed of large plates. Surface of the test covered with a multitude of small tubercles with sunken areoles that increase in size toward the peristome. The tubercles have perforated mamelons and crenulated bosses, the inter-spaces being filled with microscopic granulations. Peripetalous fasciole wide and distinct, moderately bent inward between the petaloid areas except the two posterior ones. Apical disc sunken, small and situated somewhat posterior to the center of the dorsal surface, the four genital plates distinctly perforated and separated by five small radial plates. Right anterior genital plate large, convex and forming the madreporite. Peristome transversely arched, bilabiate, with prominent labrum. Periproct about the size of the peristome, elongated vertically and situated near the top of the posterior truncation.

The dimensions of a number of practically perfect specimens are as follows:

| Cat. No.<br>P 10342 | Length | Width | Height |
|---------------------|--------|-------|--------|
|                     | mm     | mm    | mm     |
| A                   | 23.4   | 23.6  | 15.3   |
| B                   | 23.3   | 21.7  | 17.    |
| C                   | 22.5   | 21.1  | 16.5   |
| D                   | 20.5   | 20.   | 15.1   |
| E                   | 17.8   | 16.3  | 11.8   |

*H. lacunosus* resembles *H. parastatus* in general form and proportions, but is distinguished from that species by its smaller size and by the sunken areoles of the tubercles. Moreover, the posterior interambulacral area is rounded, while in *H. parastatus* it is in the form of a ridge. *H. lacunosus* is similar to *H. stella* in size, but differs from it in the shape of the fasciole, the sunken areoles and the form of the anterior margin. It resembles *H. dalli* in having sunken areoles, but in general form these two species are quite dissimilar. The specific name adopted refers to the sunken areoles by which the species is distinguished.

Locality: This species is abundant at all three of the outcrops visited at Pontotoc and about 150 specimens were collected. The test is very thin and and fragile, so that of the 150 specimens less than a dozen were unbroken. Three specimens which undoubtedly belong to this species were also collected by the writer at Houston, Mississippi, associated with fossils of the Selma Chalk, but as the Ripley and Selma formations are both reported from Houston and the fossils were found at the bottom of gullies of some size, it is quite probable that the echinoids were of Ripley age.

#### Genus LINTHIA Merian 1853.

Test variable in size, oval or cordiform, grooved anteriorly, subacuminate or truncated posteriorly, tumid and gibbous dorsally, almost flat ventrally. Apical system small, eccentric anteriorly, composed of four perforated genital plates, one of which forms the madreporite, and five small radial plates. Ambulacral areas diverse; anterior one in a broad groove, pores round and small. Antero-lateral pair with petaloid parts in grooves, moderately long, divergent, nearly closing distally; pairs of pores equal or subequal. Postero-lateral pair also in sunken grooves, less divergent and shorter

than the others. Ambulacra form the greater part of the peristomal margins, and are moderately broad on either side of the sternum. Peristome eccentric in front, semilunar, with a well-developed posterior labrum. Periproct at the upper part of the posterior truncation. A peripetalous fasciole, and a lateral fasciole starts from the peripetalous fasciole close to the antero-lateral petals and passes beneath the periproct. Tubercles crowded, increasing in size as they approach the peristome, usually crenulate and perforate, and either on flat or in sunken areoles.

Range Cretaceous to Recent.

*LINTHIA VARIABILIS* sp. nov. Plate III, Figs. I-II.

Test distinctly cordate, truncated posteriorly, ventral surface depressed convex, dorsal surface elevated, forming a sharp ridge in the posterior interambulacral area. Sides inflated and sloping to the lateral and anterior margins; posterior truncation slightly concave and the angle between the truncation and the base line varying from  $77^{\circ}$  to  $90^{\circ}$ . Ambulacral areas straight, petaloid, situated in comparatively deep depressions of the dorsal surface. Antero-lateral pair about one and one-half times the length of the postero-lateral pair, poriferous zones of these four petals wide, pores elongated and slit-like. Each pair of pores connected by a shallow groove and the pore near the border of the petal the larger. Unpaired anterior ambulacral area situated in a deep depression the continuance of which forms a sulcus in the anterior margin. Poriferous zones of this area narrow and situated far apart. Pores round and each pair separated by a tubercle. Interambulacral areas broad and composed of large plates. Surface of the test covered with minute perforated tubercles having crenulated bosses. These tubercles increase in size as they approach the peristome. Interspaces filled with small tubercles and microscopic granulations. Both peripetalous and lateral fascioles are clearly defined, peripetalous fasciole decidedly bent inward between the antero-lateral and postero-lateral petals and somewhat less so between the other petals. Apical system situated in the center or somewhat anterior to the center of the dorsal surface; small, depressed, having the four genital plates perforated and separated by five small radials. Peristome transversely elliptical, situated near the anterior margin. Labrum prominent. Periproct somewhat elongated vertically and situated near the top of the posterior truncation.



The dimensions of a number of practically perfect specimens are as follows:

| Cat. No. | Length | Width | Height | Height of Periproct | Posterior Angle | Position of Apex |
|----------|--------|-------|--------|---------------------|-----------------|------------------|
| P 10457  | mm     | mm    | mm     | mm                  |                 |                  |
| A        | 24.2   | 23.1  | 15.    | 6.5                 | 75°             | Anterior         |
| B        | 23.5   | 22.8  | 13.5   | 5.1                 | 75°             | Anterior         |
| D*       | 29.7   | 29.1  | 15 ?   | 6.6                 | 75°             | Central          |
| E        | 25.    | 24.7  | 15.3   | 6.9                 | 74°             | Anterior         |
| F        | 25.    | 23.5  | 15.7   | 6.7                 | 82°             | Anterior         |
| G        | 23.9   | 24.6  | 18.2   | 7.5                 | 85°             | Subcentral       |
| H        | 21.    | 19.7  | 15.    | 8.5                 | 79°             | Subcentral       |
| J        | 20.    | 20.   | 13.6   | 6.3                 | 85°             | Central          |
| K †      | 31.6   | 26.4? | 23.7?  | 9.5                 | 87°             | Anterior         |
| P 10458  |        |       |        |                     |                 |                  |
| L        | 26.6   | 26.4  | 19.6   | 9.8                 | 85°             | Central          |
| M        | 24.9   | 25.7  | 17.7   | 8.2                 | 84°             | Central          |
| N        | 23.8   | 23.7  | 17.5   | 8.                  | 85°             | Subcentral       |
| O        | 21.7   | 21.8  | 15.6   | 8.5                 | 85°             | Subcentral       |
| P        | 26.1   | 24.5  | 16.3   | 7.8                 | 90°             | Central          |
| S        | 24.8   | 25.3  | 14.5   | 6.6                 | 84°             | Anterior         |
| T        | 25.1   | 23.6  | 16.4   | 7.5                 | 77°             | Anterior         |
| U        | 24.2   | 24.1  | 16.2   | 7.4                 | 77°             | Anterior         |
| V        | 27.3   | 26.3  | 15.4   | 6.7                 | 73°             | Subcentral       |
| W        | 18.7   | 17.   | 10.8   | 5.1                 | 83°             | Central          |
| X        | 17.1   | 16.6  | 10.1   | 4.8                 | 77°             | Central          |

This table shows that this species exhibits great individual variation in a number of characters. Thus the proportion of length to width varies from wider than long to longer than wide; the proportion of height to length is variable; the height of the periproct varies in proportion to the height of the test; the basal line and the posterior truncation form an angle varying from 73° to 90° and the position of the apical disc varies from central through subcentral to decidedly anterior. The manner in which these variations are combined is so diverse, however, that no well-marked divisions can be made. Taking two extremes of form such as B and L we find B longer than wide, test low, periproct low, posterior angle 75°, apex anterior; in L the length and width are about equal, test high, periproct high, posterior angle 85°, apex central. This combination of characters would seem to be of specific importance, but S is wider than long, test high, periproct low, posterior angle 84°, apex anterior; F longer than wide, test high, periproct low, posterior angle 82°, apex anterior; X longer than wide, test low, periproct low, angle 77°, apex central. Hence it is evident that these variations are not constant but in-

\* Crushed vertically.

† Crushed laterally.

dividual variations. Owing to this tendency to variation, the specific name *variabilis* has been adopted.

Only one other species of this genus, *L. tumidulus*, has hitherto been described from the American Cretaceous and that species is so unlike *L. variabilis* that a detailed comparison is unnecessary.

Locality: This species is from the Ripley Group and is quite abundant both on the bluffs at One Mile Run and near the southern edge of the village at Pontotoc, Mississippi. Two casts which evidently belong to this species were also collected by the writer in the Owl Creek marls in Tippah County, Mississippi.

A careful examination of the literature reveals the fact that comparatively little attention has hitherto been paid to the echinoids of the Ripley Group of Mississippi. The following are all the references that have been found by the writer:

Journal of the Academy of Natural Sciences Philadelphia, 2d series, Vol. 4, p. 291. 1860. T. A. Conrad describes *Cassidulus abruptus* and *C. subquadratus* both from Tippah County, Mississippi.

Report of the Geology and Agriculture of the State of Mississippi, 1860, p. 92. E. W. Hilgard, State Geologist, gives a list of fossils collected from the strata of the Ripley Group in Tippah, Pontotoc and Chickasaw Counties, in which the following echinoids are listed:

*Hemiaster*, 2 species.

*Cassidulus subquadratus* Conrad.

*Cassidulus?* (*Echinanthus?*) sp.

*Cassidulus* shape of *Faujasia apicalis*.

The Echinodermata of the United States, W. B. Clark, Bull. U. S. G. S. Vol. 97, 1893. The following echinoids are noted from the Ripley Group:

*Botriopygus alabamensis* Clark. . . . . Alabama.

*Cassidulus æquoreus* Morton. . . . . Alabama.

*Cassidulus micrococcus* Gabb. . . . . Eufaula, Alabama.

*Cassidulus porrectus* Clark. . . . . Eufaula, Alabama.

*Cassidulus subconicus* Clark. . . . . Mississippi.

*Cassidulus subquadratus* Conrad. . . . . Holly Springs, Mississippi.

*Hemiaster parastatus* Morton. . . . . Alabama.

*Cassidulus abruptus* Conrad is mentioned as a doubtful species.

Geology and Mineral Resources of Mississippi, A. F. Crider. Bull. U. S. G. S. Vol. 283, 1906, p. 20. A list of the Ripley fauna at Owl Creek, Tippah County, Mississippi, as collected by Dr. T. W. Stanton is given in which *Cassidulus subconicus* and *C. subquadratus* are mentioned.

The following list shows the echinoids and associated fossils collected by the writer on the Patterson Farm, Pontotoc, Mississippi.

## ECHINOIDS

*Cassidulus subquadratus* Conrad.

*Cassidulus hemisphericus* Slocum.

*Hemiaster lacunosus* Slocum.

## BRYOZOANS

A few unidentified specimens.

## PELECYPDS

*Anomia argentaria* Morton.

*Cucullæa* sp.

*Exogyra costata* Say.

*Exogyra interrupta* Conrad.

*Gryphæostræa vomer* Morton

*Ostræa denticulifera* Conrad.

*Ostræa tecticosta* Gabb.

*Ostræa*, two unidentified species.

*Pecten* sp.

## GASTROPODS

*Turritella tippana* Conrad.

Several unidentified natural casts.

## CEPHALPODS

*Baculites*.

## CRUSTACEA

Thorax of a crab, unidentified.

## VERTEBRATES

Shark teeth and vertebræ.

The following were collected near One Mile Run and in the southern part of the town of Pontotoc:

## ECHINOIDS

*Cassidulus intermedius* Slocum.

*Hemiaster parastatus* Morton.

*Hemiaster lacunosus* Slocum.

*Linthia variabilis* Slocum.

PELECYPODS

*Exogyra costata* Say.

*Gryphæostræa vomer* Morton.

*Ostræa denticulifera* Conrad.

ACKNOWLEDGMENTS

The publications of P. M. Duncan and E. Desor have been freely drawn upon for the generic descriptions here used, but as they have been rearranged and adapted more or less they have not been treated as quotations.

President John Goff of the Chickasaw Female College, Pontotoc, Mississippi, gave the writer valuable information as to localities in the field and also later furnished specimens which materially aided in the preparation of this paper.





EXPLANATION OF FIGURE 1

Diagram illustrating the structure of the lens, showing the internal details and the external surface.

The diagram shows a cross-section of the lens, with the internal details and the external surface. The lens is shown in a circular shape, with the internal details and the external surface. The diagram is labeled with various parts, including the lens, the internal details, and the external surface.

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EXPLANATION OF PLATE I

*CASSIDULUS INTERMEDIUS* sp. nov., page 6.

Figs. 1-4. Dorsal, ventral, posterior and lateral views of the type specimen.  $\times 1$ .

Fig. 5. Portion of the left posterior ambulacral area at base of the petaloid region, greatly enlarged.

Fig. 6. Right posterior phyllode with the adjoining bourrelets, greatly enlarged.

*CASSIDULUS HEMISPHERICUS* sp. nov., page 7.

Figs. 7, 8. Dorsal and lateral views of the type specimen.  $\times 1$ .

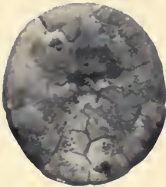
Fig. 9. Portion of the anterior ambulacral area at the base of the petaloid region, greatly enlarged.



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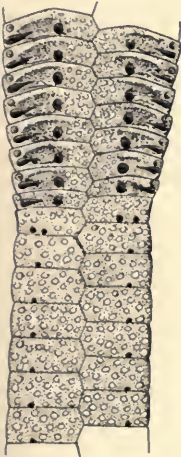
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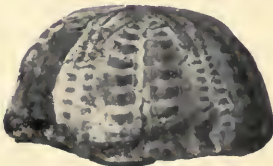
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# EXPLANATION OF PLATE II

Fig. 1. A plan view of the lens, showing the position of the optical axis and the center of curvature. The lens is represented by a circle, and the optical axis is a straight line passing through the center of the circle. The center of curvature is a point on the optical axis, outside the lens.

Fig. 2. A plan view of the lens, showing the position of the optical axis and the center of curvature. The lens is represented by a circle, and the optical axis is a straight line passing through the center of the circle. The center of curvature is a point on the optical axis, outside the lens.

Fig. 3. A plan view of the lens, showing the position of the optical axis and the center of curvature. The lens is represented by a circle, and the optical axis is a straight line passing through the center of the circle. The center of curvature is a point on the optical axis, outside the lens.

Fig. 4. A plan view of the lens, showing the position of the optical axis and the center of curvature. The lens is represented by a circle, and the optical axis is a straight line passing through the center of the circle. The center of curvature is a point on the optical axis, outside the lens.

Fig. 5. A plan view of the lens, showing the position of the optical axis and the center of curvature. The lens is represented by a circle, and the optical axis is a straight line passing through the center of the circle. The center of curvature is a point on the optical axis, outside the lens.

Fig. 6. A plan view of the lens, showing the position of the optical axis and the center of curvature. The lens is represented by a circle, and the optical axis is a straight line passing through the center of the circle. The center of curvature is a point on the optical axis, outside the lens.

Fig. 7. A plan view of the lens, showing the position of the optical axis and the center of curvature. The lens is represented by a circle, and the optical axis is a straight line passing through the center of the circle. The center of curvature is a point on the optical axis, outside the lens.

Fig. 8. A plan view of the lens, showing the position of the optical axis and the center of curvature. The lens is represented by a circle, and the optical axis is a straight line passing through the center of the circle. The center of curvature is a point on the optical axis, outside the lens.



EXPLANATION OF PLATE II

HEMIASTER LACUNOSUS sp. nov., page 10.

Figs. 1-4. Dorsal, ventral, posterior and lateral views of B, one of the type specimens.  $\times 1$ .

Fig. 5. Apical system greatly enlarged. g. genital plates. m. madreporite. r. radial plates.

Fig. 6. Portion of the anterior petal where it joins the apical system, greatly enlarged.

Fig. 7. Several plates of the right anterior petal, greatly enlarged.

Figs. 8, 9. Top and side views of a tubercle, greatly enlarged.



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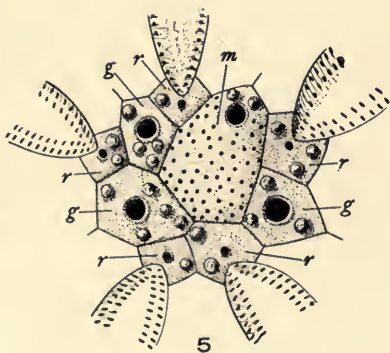
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EXPLANATION OF PLATE III

*LINTHIA VARIABILIS* sp. nov., page 12.

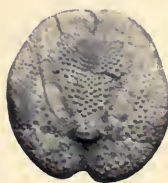
- Figs. 1-4 Dorsal, ventral, posterior and lateral views of Cat. No. P 10457 B.  
×1.  
Figs. 5-8. Dorsal, ventral, posterior and lateral views of Cat. No. P 10458 L.  
×1.  
Fig. 9. Apical system, greatly enlarged.  
Fig. 10. Several plates of the left posterior petal, greatly enlarged.  
Fig. 11. Several plates of the anterior petal, greatly enlarged.



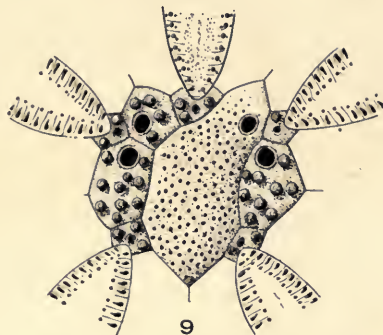
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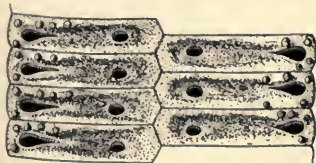
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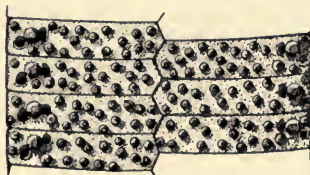
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